

Comment on “Correlation of Tunneling Spectra in $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ with the Resonance Spin Excitation”

In a recent Letter Zasadzinski *et al.* [1] reported scanning tunneling spectroscopy on $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ (Bi2212) and an interpretation of the data. In this Letter, the tunneling data are practically identical to their previously published data [2] and, therefore, do not present a new contribution to the existing literature. The main point of their latter work was to present a new interpretation of the data, namely, to link dips in tunneling conductances with the so-called magnetic resonance peak observed in inelastic neutron scattering (INS) measurements [3].

The tunneling conductances obtained at low temperature in Bi2212 have a well-defined structure—the presence of quasiparticle peaks, dips and humps. In a superconductor-insulator-normal metal (SIN) junction, the conductance peaks are located at a bias $V_{peak} = \Delta/e$, while in a superconductor-insulator-superconductor (SIS) junction, they appear at $V_{peak} = 2\Delta/e$, where Δ is the energy gap, and e is the electron charge. The authors of Ref. [1] measured the difference $\Omega = e(V_{dip} - V_{peak})$ in SIS conductances as a function of doping level p , where V_{dip} is the dip bias. They found that $\Omega(p) \simeq E_r(p)$, where E_r is the energy at which the magnetic resonance mode is situated in INS spectra. By analogy with phonon structures in tunneling conductances obtained in conventional superconductors, they concluded that the dips in tunneling conductances of Bi2212 are caused by the magnetic excitation seen by INS. Below, we show that their interpretation of the data is incorrect.

First, earlier [4] and recently [5] it was *experimentally* shown that the dips in tunneling conductances “have no physical meaning” and “appear naturally due to a superposition of two contributions” (peaks and humps). Angle-resolved photoemission (ARPES) measurements performed in Bi2212 fully support the latter scenario [6]. The correlation $\Omega(p) \simeq E_r(p)$ found in Ref. [1] for Bi2212 is a chance coincidence.

Secondly, the authors of Ref. [1] wrote: “It should be noted that a similar dip has been observed in the superconducting tunneling spectra of a heavy fermion superconductor [7] which has also been linked to a peak that develops in the spin excitation spectrum. Thus, a spin fluctuation mechanism may have a more general relevance to superconductors beyond the high T_c cuprates.” Indeed, SIN tunneling conductances obtained in the heavy fermion UPd_2Al_3 [7] are reminiscent of those measured in Bi2212, and it is generally believed that spin fluctuations mediate superconductivity in UPd_2Al_3 . Then, if the correlation $\Omega \simeq E_r$ is valid for Bi2212, it must be valid for UPd_2Al_3 too. However, this is not the case. Experimentally, in UPd_2Al_3 $\Omega = eV_{dip} - eV_{peak} \simeq 0.88 - 0.235 = 0.645$ meV [7], while $E_r = 1.5\text{--}1.65$ meV

[8–10]. Thus, in UPd_2Al_3 the value $\Omega = 0.645$ meV is more than twice smaller than the value $E_r = 1.5\text{--}1.65$ meV. Therefore, the dips in tunneling conductances obtained in UPd_2Al_3 can not be caused by the spin excitation associated with the magnetic resonance mode in INS spectra.

Thirdly, return to cuprates: the authors of Ref. [1] wrote: “As a final comment, we note that similar dip feature have been observed in the tunneling spectra of $\text{Tl}_2\text{Ba}_2\text{CuO}_6$ indicating that the neutron resonance ought to be observed in a cuprate with a single Cu-O layer per unit cell.” Experimentally, in near optimally-doped $\text{Tl}_2\text{Ba}_2\text{CuO}_6$ $\Omega \simeq 16$ meV [11], while $E_r \simeq 47$ meV [12]. Thus, in $\text{Tl}_2\text{Ba}_2\text{CuO}_6$ the value $\Omega \simeq 16$ meV is three times smaller than the value $E_r \simeq 47$ meV. Therefore, the dips in tunneling conductances obtained in $\text{Tl}_2\text{Ba}_2\text{CuO}_6$ can not be caused by the spin excitation.

To summarize, undoubtedly, the spin excitation manifesting itself as a resonance peak in INS spectra is an important part of the mechanism of unconventional superconductivity in cuprates and heavy fermions [5]. However, the dips in tunneling conductances obtained in these unconventional superconductors, as shown above, have nothing to do with this magnetic excitation.

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